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STUDIES ON THE RELATION OF INSECT LOSS TO MANAGEMENT POLICY.

Sierra National Forest, Calif.

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STUDIES ON THE RELATION OF INSECT LOSS TO MANAGEMENT POLICY

SIERRA NATIONAL FOREST.

The first study, on the Prescott Timber Sale Area (See memorandum of March 6, 1924, by Person, "Relation of Insect Loss to Cutting Policy on the Prescott Timber Sale Area"), was suggested by Forest Examiner, Sanford who found that the insect loss on the area was high and the increment exceptionally low. The results of this study were somewhat remarkable, showing an increment of only 18.5% of the insect loss. It was decided to continue these studies on a number of cutover areas on the Sierra National Forest, including a variety of conditions.

To our knowledge, the only previous work along this line was done by Duncan Dunning of the Forest Service, District 5 Office. In his report of February 1, 1922, "Some Results of a Cutting Study in California", on page 26 he gives the total average annual loss for 13 sample plots as .37% by volume. This includes losses from insects, windfalls, mistletoe, fungi, brush burning, logging, snow and suppression. He states that "the greatest volume losses were due to wind and barkbeetles (Dendroctonus) in yellow pine," also that, "windfall and death from other causes is usually heaviest during the first 5 years after logging." No attempt was made in this report to separate the insect loss from other losses or to compare directly the insect loss and increment on different sites. The present studies are intended as a more detailed check on the insect losses alone, the object being to determine just how much of a factor the insect loss is under different conditions and what allowances might be made for this factor in the marking practice.

Only yellow pine and sugar pine were considered in these studies which include six areas. All of the areas are located in the Sierra National Forest. The methods used and the results for each area are given in outline form to make the studies easy of comparison. Where possible check cruises were made in adjoining uncut timber of the same type to aid in determining the relation of the infestation in the cutover areas to the infestation in the surrounding uncut stands.

The western pine barkbeetle (Dendroctonus brevicomis) is responsible for practically all of the insect killed yellow pine and the mountain pine beetle (D. monticolae) is responsible for the insect killed sugar pine.

The insect cruises of the areas were made by Person and Entomological Ranger, Wagner. On all the areas except the Prescott, the insect loss is based on a 100% strip cruise of the cutover area. The 1921, 1922 and 1923 losses were used. The increment cores were taken by Sanford, Person and Wagner. The present volume on the areas, marking practice and method of

logging were taken from the Timber Inventory Record of the Sierra Forest.

In figuring the annual increment the % of increase in basal area was used as an index to the increase in volume. A number of increment cores were taken from each area and the average width of all the rings counted in the last inch doubled to give the increase in diameter. The average size of the trees was estimated for each area and the whole increment figured on the basis of this average tree. As the number of cores taken was not very large, the percent of increase was compared with Dunning's figures in the report previously referred to.

All of the sites except the Prescott area run close to a number II. site, some a little poorer and some a little better. Dunning found (see Table 1 in Report, "Some Results of Cutting in the Sierra Forests of California"), that the increment of yellow pine on such sites in the 24" - 29" diameter class ran from .70 to 1.29%. On the basis of the cores taken we found the increment would run from .73% to 1.25%. Dunning's figures for sugar pine on Site II. show an annual increment of 2.07% while our cores indicate an annual increment of from 1.07 to 2.2% on sites that average a little poorer than II.

This close agreement with Dunning's figures which are based on a study of 466 yellow pine and 81 sugar pine show that the increments used are reasonably accurate.

1. Study #1 - Prescott Area.

2. Parts of Sections 28, 29, 30, 31, 32 and 33 in T 9 S. R 34 E.
Parts of Sections 4,5, and 6 in T. 10 S. R. 24 E.

3. Examined Feb. 12 and 13, 1924.

4. Logged - 1918 - 1923

5. The total actual cutover area includes 1240 acres.
The elevation is between 3200' and 4500'
The forest type is pure yellow pine.
The soil is a rocky decomposed granite of little depth.
The area is classed as Site IV.
The topography is rolling to steep with drainage to the north

6. The area was carefully logged with teams, donkey engines and motor trucks leaving the area in good condition with very little damage from logging.
The slash was lopped and burned.
The late selection system of marking was used under which 87.5% of the original stand was taken out.

7. The present stand on the area, based on a cruise in February 1924, is 2190 M.B.M. or an average of 1.8 M. per acre. There is also a small amount of incense cedar on the area.
The reproduction is fair.
The ground cover consists of brush or needles and duff.

8. Annual Increment: The annual increment was estimated by Sanford from a number of increment cores selected thruout the area. He found the increment to be .36% or 6 Bd. Ft. per acre.

9. The insect loss based on a 100% cruise of two half sections, supplemented by a topographic cruise of the entire area was placed at 63 trees for the 1240 acres for 1923. The average volume of these trees is 640 Bd. Ft. This gives an insect loss for one year of 40,320 Bd. Ft. for the area or 32.5 Bd. Ft. per acre.

10. Relation of Insect Loss to Increment:

This area shows an annual increment of 6 Bd. Ft. per acre and an insect loss of 32.5 Bd. Ft. per acre.
The increment amounts to only 18.5% of the loss from insects.

1. Study #2 - Shaver Area.

2. Sec. 16 T. 9S. R. 25E.

3. Examined May 8 and 9, 1924.

4. Logged 1907 - 1911

5. The area includes approximately 600 acres or all of section 16 except about 40 acres in the N.W. ¼ which is nearly pure fir.
The elevation is between 5800' and 6300'.
The type is yellow pine - sugar pine with approximately -

35%	Yellow Pine
45%	Sugar Pine
12%	White Fir
8%	Incense Cedar

The soil is a sandy loam with a rocky decomposed granite soil.
The area is classed as 20% Site I. and 80% Site II.
The topography is moderately steep to rugged with drainage to the south and principal exposures to the south, southeast and southwest.

6. The area was logged with low speed, ground lead power skidders and log chutes. Logging was carefully done, leaving the area in good condition.
The selection system of marking was used and a good stand of large mature trees up to 60" in diameter was left on the area.
The slash was lopped, piled and burned.

7. The area when cruised in 1919 had -

		Average per Acre Bd. Ft.
Yellow Pine	3,156,340 Bd. Ft.	5,260.6
Sugar Pine	3,896,150 " "	6,493.6
White Fir	2,073,160 " "	
Incense Cedar	813,720 " "	

The reproduction is poor.
The ground cover is largely brush with small open areas of needles and duff.

8. Annual increment for yellow pine and sugar pine -

	Yellow Pine	Sugar Pine
Basis, number of increment cores	15	8
Number of rings in last inch	18.3	14
Aver. annual increase in diameter	.11 in.	.16 in.
Aver. diameter of trees, (estimated)	30 "	30"
Aver. annual increment in percent	.73%	1.07%
Aver. annual increment in Bd.Ft. per acre	38.40	69.48

9. Insect loss for yellow pine and sugar pine -

Cutover Area

	1921		1922		1923		Aver. Loss Per Acre in Bd. Ft. (1921 - 1923)
	# trees	Vol.	# trees	Vol.	# trees	Vol.	
Yellow Pine	7	35,700	8	33,500	6	16,300	47.5
Sugar Pine	11	28,790	12	54,450	8	27,770	61.7

Uncut Check Area

No suitable stand of uncut timber adjoins section 16, but a ½ section check was cruised along the highway between Carlson and Shaver; about 3 miles north of section 16 in a very similar type. This check showed an average annual loss per section for 1922 and 1923 of 11 yellow pine with a volume of about 9,570 Bd. Ft. and 7 sugar pine with a volume of about 8,750 Bd. Ft.

This is an average loss under normal endemic conditions.

10. Relation of Insect Loss to Annual Increment -

Annual increment per acre	Yellow Pine	38.40 Bd. Ft.	
	Sugar Pine	69.48 " "	
Annual insect loss per acre	Yellow Pine	47.5 " "	0.90
	Sugar Pine	61.7 " "	0.95

On this area of 600 acres the insect loss in the yellow pine is 124% of the increment and the insect loss in the sugar pine is 89% of the increment. Taking the two species together the insect loss more than balances the increment and causes an actual loss in volume of the trees over 12" in diameter.

1. Study #3 - Blue Canyon Area.

2. Sec. 30, S.E. ¼ and S.E. 1/16 of N.E. ¼.
Sec. 29 W. ½ of S.W. ¼ and S.W. 1/16 of N.W. ¼
T. 10S. R. 25E.

3. Examined May 14, 15, 1924.

4. Logged 1907 - 1910.

5. The area includes 360 acres at an elevation of from 4200' to 4500'.

The forest is of the yellow pine type with-

78% Yellow pine
5% Sugar pine
15% Incense cedar
2% White fir.

The soil is a sandy loam with large rock outcrops and shallow soil except along the creek bottom where the soil is fairly deep.
The area is classed as 10% site I., 50% site II., and 40% site III.
The topography is rolling to steep with small level flats along the creek.
The drainage is to the south with principle exposures to the south, southeast and southwest.

6. The area was logged by means of low speed, ground lead, power skidders and log chutes. The brush was lopped, piled and burned, leaving the area in good condition.

The selection system of marking was used and although the cut was heavier than in the Shaver area a large number of mature trees of over 30 inch diameter were left.

7. The present volume based on a cruise in 1919 is-

		Aver. per acre in Bd.Ft.
Yellow Pine	1,559,990 Bd. Ft.	4,333
Sugar Pine	105,480 " "	
Incense Cedar	265,750 " "	
White Fir	28,460 " "	

The reproduction is good over most of the area.
The ground cover is principally bear clover with brush patches and openings with needles and duff.

8. Annual increment for yellow pine -

Basis, number of increment cores	20
Number of annual rings in last inch	19
Aver. annual increase in diameter	.106"
Aver. diameter of trees on area (estimated)	24"
Aver. annual increment in percent	.83%
Aver. annual increment in Bd.Ft. per acre	36

9. Insect loss for yellow pine -

Cutover Area - 360 Acres

	1921		1922		1923		Aver. annual loss per acre
	# trees	Vol.	# trees	Vol.	# trees	Vol.	
Yellow pine	9	15,490	6	8,020	3	3,410	25 Bd. Ft.

Uncut Check Area - ¼ section was cruised for insect loss in the virgin timber joining the cutover area on the east.

The 100% strip method of cruising was used.

	1921		1922		1923		Aver. annual loss per acre
	# trees	Vol.	# trees	Vol.	# trees	Vol.	
Yellow pine	2	2,760	6	5,840	11	17,810	55 Bd. Ft.

It is noticeable that while the insect loss on the cutover area decreased during the three year period the infestation in the adjoining uncut check has increased.

Such local variations in infestations are frequently encountered.

The 1923 loss of 11 trees or 17,810 Bd. Ft. on a quarter section which would amount to 44 trees or 71,240 Bd. Ft. on a section shows an increasing epidemic condition that warrants a more complete survey of this area.

The infestation in the cutover area for the three year period shows an endemic condition.

10. Relation of Insect Loss to Annual Increment.

Annual increment per acre	36 Bd. Ft.
Annual insect loss per acre	25 " "

The insect loss on this area of 360 acres is 70% of the increment with the insect infestation at a normal or endemic stage.

1. Study #4 - Summit Camp.

2. A strip of timber along a ridge averaging about 18 chains wide running thru the east ½ of Sec. 17 and into N.E. ¼ of Sec. 20, T. 5S. R 21E.

3. Examined May 20, 1924.

4. Logged 1916 - 1917.

5. The area includes approximately 160 acres.
The elevation is between 5600' and 6100'.
The forest type is yellow pine-sugar pine with

13% Yellow pine
52% Sugar Pine
25% White Fir
10% Incense cedar

The soil is a rocky decomposed granite.
The site is classed as No. II.
The topography is steep with varying exposures.

6. Logging was done with low speed ground lead power skidders, and log chutes. The small slash was burned but a considerable amount of broken timber was left on the area. This has been added to by an unusually large number of windfalls; entire trees and broken tops.
The group selection of marking was used and a light stand of trees was left. The loss, however, has been excessive both from windfall, due to the exposed nature of the area, and insects.
There was no insect loss in the yellow pine.

7. The volumes left on the area after logging, based on a cruise in 1922, are as follows:

		Aver. per Acre in Bd.Ft.
Yellow pine	93,600 Bd.Ft.	585
Sugar pine	360,800 " "	2,255
White fir	176,000 " "	
Incense cedar	82,000 " "	

8. Annual increment for yellow pine and sugar pine -

	Yellow Pine	Sugar Pine
Basis, number of increment cores	2	10
Number of rings in last inch	11.5	7.7
Aver. annual increase in diameter	.18	.26
Aver. diameter of trees (estimated)	20"	24"
Aver. annual increment in percent	1.00%	2.2%
" " " in Bd.Ft. per acre	5.85	49.6

9. Insect loss for sugar pine. (No insect loss was found in the yellow pine.)

Cutover area - 160 acres

	1921		1922		1923		Aver. annual loss
	# trees	Vol.	# trees	Vol.	# trees	Vol.	per acre
Sugar pine	5	6,390	11	9,830	7	6,190	46.7 Bd.Ft.

Uncut Check area - 160 acres in a strip from Summit Camp toward Signal peak.

	1921		1922		1923		Aver. annual loss
	# trees	Vol.	# trees	Vol.	# trees	Vol.	per Acre
Sugar pine	4	9,090	4	9,650	3	9,580	59 Bd. Ft.

This shows a normal endemic infestation, both in the cutover and in the uncut area.

10. Relation of Insect Loss to Increment.

Annual increment in Bd.Ft. per acre	Yellow pine	5.85
	Sugar pine	49.60
Annual insect loss in Bd.Ft. per Acre	Yellow pine	0
	Sugar pine	46.7

The insect loss in the sugar pine, which makes up over 50% of the stand, amounts to 90% of the increment. No insect loss was noted in the yellow pine.

As the windfall on this area has been very heavy it is certain that at the present rate of loss a large part of the trees left for increment will be lost before the next cut.

1. Study #5 - Miami Area

2. Sec. 28 S.E. ¼ T. 5S. R. 21E.

3. Examined May 20, 1924.

4. Logged 1905-1906

5. The area includes 160 acres.

The elevation is between 5000' and 5500'.
The forest type is yellow pine - sugar pine with -

17% Yellow pine
35% Sugar pine
26% White Fir
22% Incense cedar

The site is classed as 30% I. and 70% II., with a rocky decomposed granite soil.

The topography is steep with drainage to the south and principal exposures to the south, east and west.

6. Logging was done with low speed, ground lead, power skidders and log chutes. The slash was lopped, piled and burned leaving the area in fairly good condition.
The selection method of marking was used, leaving a fair stand of merchantable timber with trees up to 50 inches in diameter.

7. The volume of timber left on the area based on a cruise in 1922, is as follows:

		Aver. per acre
Yellow pine	434,000 Bd. Ft.	2,713 Bd. Ft.
Sugar pine	875,000 " "	5,469
White fir	619,000	
Incense cedar	555,000	

The reproduction is fair.
The ground cover consists of brush, bear clover and open areas with needles and duff.

8. Annual increment for yellow pine and sugar pine. -

	Yellow pine	Sugar Pine
Basis, number of increment cores	6	7
No. of rings in last inch	12	12
Aver. annual increase in diameter	.166	.166
Aver. diameter of trees(estimated)	24"	24"
Aver. annual increment in percent	1.12%	1.12%
" " " in Bd.Ft.per acre	30.37	61.25

9. Insect loss for sugar pine - (No yellow pine insect loss was found for 1921-23)

Cutover area - 160 acres.

	1921		1922		1923		Aver. annual loss
	# trees	Vol.	# trees	Vol.	# trees	Vol.	per acre
Sugar pine	1	5,440	1	670	0	0	13

Uncut check area.

No suitable check area was available but it was noted that the insect loss over the general area was very low.

10. Relation of Insect Loss to Increment -

Annual increment in Bd. Ft. per acre	(Yellow pine	30.37
	(Sugar pine	61.25
Annual insect loss " " " " "	(Yellow pine	0
	(Sugar pine	13 0.23%

This area is unusually free from insect loss, only a very small part of the increment, 14% in the case of sugar pine, being taken by this form of injury. On the basis of our present knowledge we could not say whether this insect loss would become greater or not, but it is probable that it will.

1. Study #6 - Miami Road Area.

2. Sec. 3. N.E. S.E. of S.W. and S.W. of S.E.
" 10 N.E. of N.W. T. 6S. R. 21E.

3. Examined May 21, 1924.

4. Logged 1907.

5. The area includes 160 acres.
The elevation is between 4500' and 4900'
The forest type is yellow pine, with-

60% Yellow pine
10% Sugar pine
12% White fir
18% Incense cedar.

The site is classed as 20% I. and 80% II.
The soil is a decomposed granite of fair depth over much of the area.
The topography is steep with drainage to the southeast and principal exposures to the south, southeast and southwest.

6. Logging was done with low speed, ground lead, power skidders, and log chutes. The slash was lopped, piled and burned and the area was left in good condition.
The selection method of marking was used, leaving a fair stand of good quality timber on the area.

7. The volume of timber on the area at the time of the 1922 cruise is as follows:

		Aver. per acre.
Yellow pine	669,620 Bd. Ft.	4,185 Bd.Ft.
Sugar pine	110,340 " "	690 " "
White fir	156,010 " "	
Incense cedar	200,860 " "	

The reproduction is fair.
The ground cover is largely brush and bear clover with some openings with needles and duff.

8. Annual increment for yellow pine-

Basis, number of increment cores	9
Aver. number of rings in last inch	13.6
Aver. annual increase in diameter	.148
Aver. diameter of trees (estimated)	24"
Aver. annual increment in percent	1.25
" " in Bd.Ft. per acre	52.31

9. Insect loss for yellow pine -

Cutover area - 160 acres

	# trees	Vol.	# trees	Vol.	# trees	Vol.	Aver. annual loss per acre.
Yellow pine	4	3,270	1	4,480	0	0	16 Bd. Ft.

Uncut check area.

The insect loss in the uncut adjoining timber was determined by a combination topographic and strip cruise. The average loss is 5 to 10 trees per section which is a low endemic infestation.

10. Relation of Insect Loss to Increment -

Average annual increment per acre (Yellow pine) 52.31 Bd.Ft.

Average annual insect loss per acre (Yellow pine) 16 Bd.Ft.

This area also has a very low insect loss amounting to only 30% of the increment.

Summary of Conclusions.

These studies apply only to yellow pine and sugar pine since the insect loss for the other species in this section is negligible.

For the summary of the most important points brought out by these studies, see Table I. and Plate I. and II.

It is evident that the amount of work done has not been sufficient to determine definitely the true average insect loss in either yellow pine or sugar pine, on cutover stands as a whole. Neither are there sufficient data to make the figures on the percent of increment lost thru insects, or the average number of insect killed trees to the section universally applicable. However, it is believed that the figures, for the areas under consideration, are reasonably accurate and are at least indicative of conditions on cutover areas of the Sierra National Forest.

On the basis of these studies it seems apparent that even under endemic infestations we must figure on a loss of increment, varying from 14% to 100% of the total and probably averaging around 50%. This should certainly be considered in the preparation of management plans. This insect loss, on the areas studied, varied in general with the infestation in the surrounding timber.

Under present marking practice we are leaving from 2 to 5 trees over 12" D.B.H. to the acre as the basis for a second cut, figuring on a return in from 50 to 75 years. This would amount to an average of 3 trees per acre or 1920 trees to the section. The average annual insect loss on the five Site II. areas, (Prescotts is not included because it is a Site IV. area on which no trees would normally be left for increment) is 13+ trees per section during an endemic state of infestation. If this continues for a fifty year period, it would mean a loss of 650 trees or approximately 34% of the pine trees left for the second cut. If the cutting cycle be extended to 75 years the loss would be 975 trees or 50%. On area IV. which is the worst of these five areas, the annual loss was 30 pines per section. A 75 year return on this area would see every pine tree, which had been left as the basis for a second cut, killed by barkbeetles. The least infested area would see 225 or approximately 11% killed.

Although these losses are higher than any we have seen reported for cutover areas, we believe they are not unusual for this forest and that further study will reveal similar conditions thruout the Western Sierra pine belt.

an annual insect loss of 50% of the increment; or the loss within 75 years of 50% of the pine trees left as the basis for a second cut, calls for some sort of remedy. Two possible solutions to this problem suggest themselves. One is, to reduce the insect loss by direct control and the other is to modify the marking practice in cases where such losses appear probable. Whether this modification will take the form of clear cutting with dependence on advance reproduction as the basis for the next stand, a reduction in the number of trees left or some other form will have to be worked out. Further studies may make possible the classification of stands according to the degree of susceptibility to insect attack. This would simplify the problem as these areas could be treated independently while all the other areas could be handled according to present marking plans.

To reduce the insect loss by direct control methods would call for work not only in the cutover areas but in the surrounding uncut stands, where present, as well. The reason for this is that it is not practicable to treat a small body of timber unless it is isolated in some way, topographically or by type, from other infested timber since the infestation will spread from the untreated to the treated timber. In the light of our present knowledge it would not be practical to do insect control work in such areas where the infestation is in the endemic stage. It is not only very difficult to materially reduce the loss from an endemic infestation but the costs would be so high as to be prohibitive. Therefore, it is very probable that the solution to this problem will depend on modified forest management or marking plans rather than on direct control measures.

Enough work has been done to show that the insect loss in yellow pine and sugar pine on cutover areas is a very important factor in the making of any management plan. More work should be done to determine how general this loss is and what can be done to reduce it.

TABLE I.

Area	Type	Size in Acres	Logged	Site Class	Annual Increment per A. Y. Pine %	Y. Pine Bd.Ft.	S. Pine %	S. Pine Bd.Ft.	Annual Insect Loss per Acre Y. P. Bd.Ft.	S. P. Bd.Ft.	Insect Loss in % of Increment Y. P.	S. P.	Y.P.&S.P. together
1. Prescott*	YP.-	1240	1918-1923	IV.	.36	6			32.5		540.		
2. Shaver	Y.P.-S.P.	800	1907-1911	II.	.73	38.4	1.07	69.48	47.6	61.7	124.	89.	101.24
3. Blue Canyon	Y.P.-	360	1907-1910	II.-	.83	36.	-	-	25.0	-	70.	-	70.
4. Summit Camp	Y.P.-S.P.	160	1915-1917	II.	1.00	5.85	2.20	49.6	0	46.7	-x	90.	84.
5. Miami	Y.P.-S.P.	160	1905-1906	II.-	1.12	30.37	1.12	61.25	0	13.0	-x	42.	14.
6. Miami Road	Y.P.-	160	1907-	II.-	1.25	52.31	-	-	16.0	-	30.	-	30.
Average for Site II. Areas					.99	32.59	1.46	60.11	17.7	40.5	25.	74.	60.

* The Prescott area was not included in figuring the averages because it represents a number IV. site on which no trees are left for increment under the present marking practice.

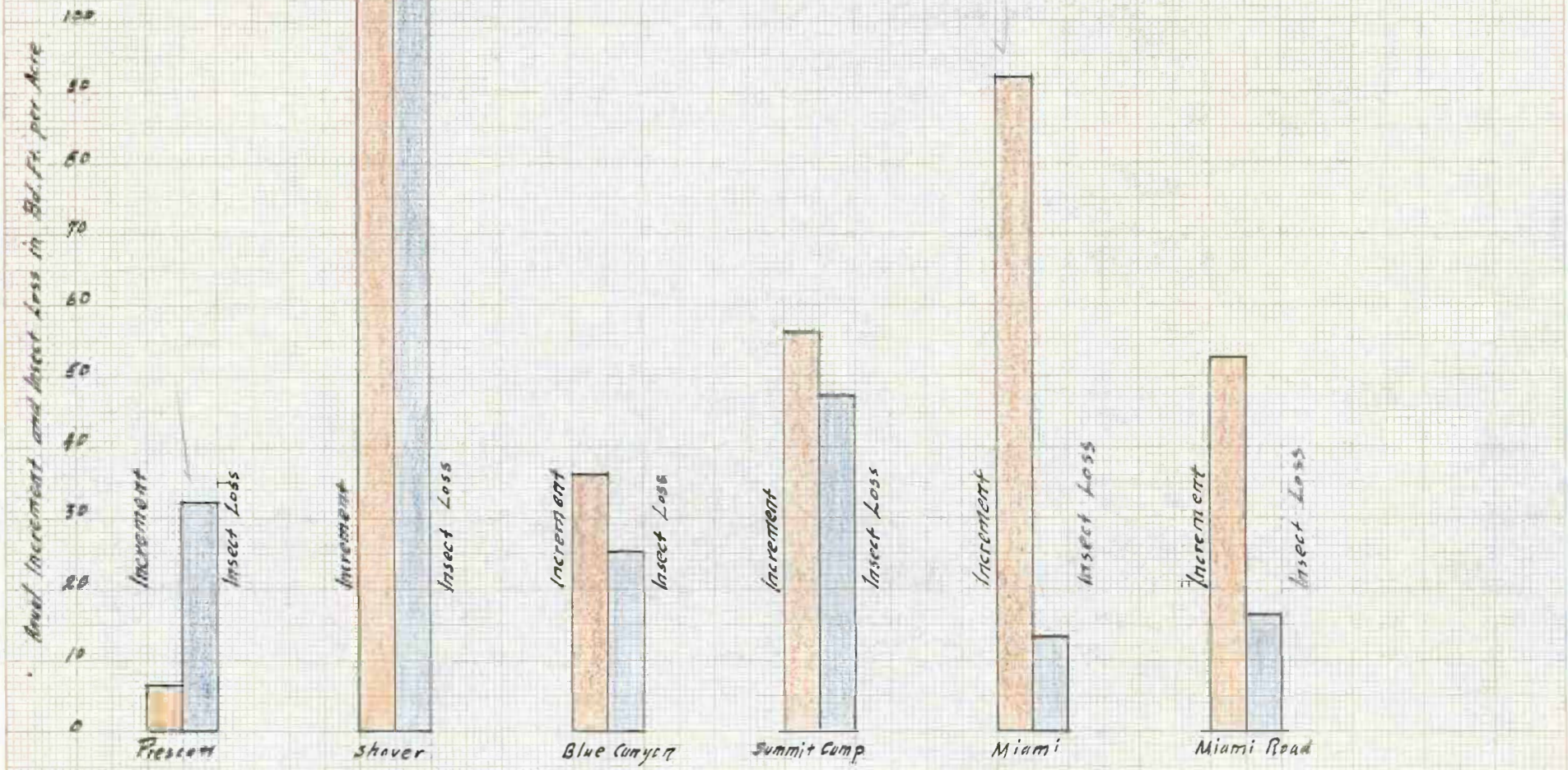
x In areas 4 and 5 where no insect loss was found in the yellow pine there was only a very light stand of yellow pine, 585 Bd.Ft. per acre in 4 and 2712 in 5. Over a longer period there would be some insect loss as trees killed before 1921 were found. This loss could not be figured accurately, so was not included.

H.W. Webb, Glen Ridge, N.J. —Negative 2.

PLATE I

Comparative Chart

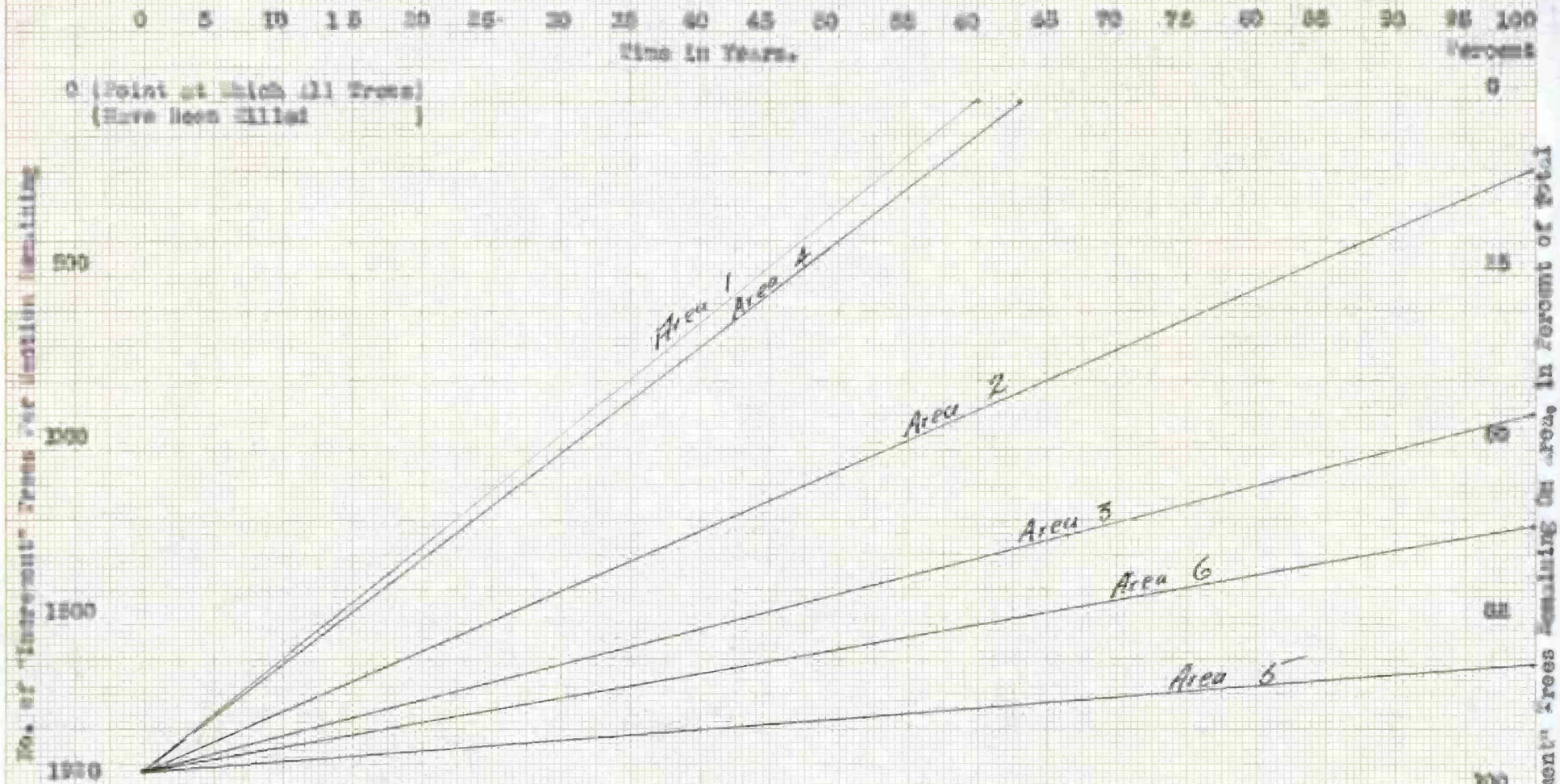
Showing Relation Between Insect Loss and Increment.



BS. 24

H.W. Webb, Glen Ridge, N.J. PLATE 2. —Negative 2.

Graph Showing The Rate At Which
The Different Insect Losses On The Areas Studied
Will Kill The Trees Which Were Left For Increment.



Note 1. According to Present Marking Practice an average of 3 Trees Per Acre or 1920 Trees Per Section are left on All Sites, and better, for Increment.

35 '24